Mechanical Engineering

Course Structure
Academic Session 2020-21 onwards
SEMESTER VI

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	ME601	Solid Mechanics	4	1	0	4
2.	ME602	Automobile Engineering	3	1	0	3
3.	ME603	Design of Transmission System	3	1	0	3
4.*	ME604 ME605 ME606	Computer Aided Design Mechatronic Systems Microprocessor in Automation	3	1	0	3
5.**	ME607 ME608 ME609	Operations Research Reliability Engineering Machine Tool Design	3	1	0	3
		Laboratory/Sessionals				
1.	ME601P	Solid Mechanics	0	0	3	1
2.	ME602P	Automobile Engineering	0	0	3	1
3.	ME604P	Manufacturing Lab	0	0	3	1
4.	ME607P	Computer Aided Design	0	0	3	1
5	IN601	Internship/Tour & Training/Industrial Training	0	0	2	2
Total Credit						**22**

***Professional Elective II**

**** Open Elective II**

SOLID MECHANICS

Course Code – ME601

Objectives:

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Contents:

Module-I

Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, strain gauges and rosettes. **(8hrs)**

Module-II

Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions, octahedral shear stresses. **(8hrs)**

Module-III

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition. **(6hrs)**

Module-IV

Plane stress and plane strain problems, introduction to governing equations in polar and cylindrical coordinates, axisymmetric problems. **(7hrs)**

Module-V

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration, thermo-elasticity. **(8hrs)**

Module-VI

Solutions using potentials energy methods, Introduction to plasticity. **(5hrs)**

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand the deformation behavior of solids under different types of loading.
2. Find mathematical solutions for simple geometries under different types of loading.
3. Transform the state of stress from one set of co-ordinate axes to another set of co-ordinate axes.
4. Apply compatibility equation for different system of strain.
5. Find the mathematical solution for axisymmetric problem.
6. Understand the concept of elasticity and plasticity.

Text Books:

[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.

[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.

[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

[4] S M A Kazimi, Solid Mechanics, Mc Graw Hill, 2016

AUTOMOBILE ENGINEERING

Course Code – ME602

Objectives:
To understand the construction and working principle of various parts of an automobile

Contents:

Module-I
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, (5)

Module-II
Engine auxiliary systems, fuel supply system, starting system, ignition system, electronic injection for SI and CI engines, engine lubrication and cooling system, engine emission control by 3-way catalytic converter system, Emission norms .(10)

Module-III
Transmission systems, AWD and 4WD transmission, clutch types & construction, gear boxes, Automatic transmission, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, (6)

Module-IV
Steering geometry and types of steering gear box, power steering, types of front axle, wheel alignment types of suspension systems. (5)

Module-V
General braking requirement, elementary theory of shoe brake, weight transfer, mean lining pressure and heat generation during braking, mechanical Pneumatic and hydraulic braking systems, power brake, antilock braking system(ABS), (6)

Module-VI
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion &emission characteristics of alternative fuels in SI and CI engines. Electric and Hybrid vehicles, application of Fuel Cells, (10)

Module-VII

Course Outcomes:
Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:
(i)Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
(ii) Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi,2002.
(iii)Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
(iv)Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

DESIGN OF TRANSMISSION SYSTEM

Course Code – ME603

Objectives:

- To learn about the design procedures for mechanical power transmission components

Contents:

Module-I

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets. **(6 hrs)**

Module-II

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. **(6 hrs)**

Module-III

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears. **(4 hrs)**

Module-IV

Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. **(4 hrs)**

Module-V

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine too applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. **(10 hrs)**

Module-VI

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes. **(6 hrs)**

Module-VII

External shoe brakes, internal expanding shoe brake. **(4 hrs)**

Course Outcomes:

1. Upon completing this course the students will be able to design transmission systems for engines and machines.

Text Books:

(i) Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8thed., Tata McGraw Hill, 2010.

(ii) Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.

(iii) Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

COMPUTER AIDED DESIGN

Course Code – ME604

Objectives:

- To provide an overview of how computers can be utilized in mechanical component design

Contents:

Module- I

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation **(8 hrs)**

Module- II

Geometric Modelling- straight line, representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves **(5 hrs)**

Module- III

Techniques of surface modelling, plane surface, cylindrical surface, surface of revolution, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces **(6 hrs)**

Module- IV

Fundamental of solid design, parametric space of a solid, surface and curves in a solid, Solid modelling techniques, CSG and B-rep. **(6 hrs)**

Module- V

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation **(5 hrs)**

Module- VI

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards **(12 hrs)**

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Use computer and CAD software for modelling mechanical components
2. draw different types of curves in 2D
3. draw different types of surface
4. draw solid modelling
5. assembly of different part modelling

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

MECHATRONIC SYSTEMS

Course Code – ME605

Objective:

- To provide an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Contents:

Module-I

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface. **(8hrs)**

Module-II

Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.**(5hrs)**

Module-III

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control**.(5hrs)**

Module-IV

Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems**.(6hrs)**

Module-V

Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc**.(8hrs)**

Module-VI

Micro mechatronic systems: Micro sensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. **(10hrs)**

Course Outcomes:

- To understand the structure of microprocessors and their applications in mechanical devices
- To know the use of various sensors and transducers
- To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
- To know the static and dynamic characteristics of actuators
- To understand the use of micro-sensors and their applications in various fields

Text Books:

1. Devdas Shetty & Richard A. Kolk, *Mechatronics System Design*, PWS Publishing Company (Thomson Learning Inc.)
2. William Bolton, *Mechatronics: A Multidisciplinary Approach*, Pearson Education
3. R. K. Rajput, *A Textbook of Mechatronics,* S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

MICROPROCESSOR IN AUTOMATION

Course Code – ME606

Objectives:

- To introduce the basic concepts of Digital circuits, Microprocessor system and digital Controller.

Contents:

Module- I

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. **(10 hrs)**

Module- II

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. **(3 hrs)**

Module- III

Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255). **(10 hrs)**

Module- IV

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features **(10 hrs)**

Module- V

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z Transform, Digital Filters, Implementation of Digital Algorithm. **(7 hrs)**

Course Outcomes:

1. Students who have done this course will have a good idea of the use of microprocessers for automation.

Text Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.

3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

OPERATIONS RESEARCH

Course Code-ME 607

Course Objectives **:** This course enables the students:

(1) Formulate a real-world problem as a mathematical programming model
(2) Know the theoretical workings of the simplex method for linear programming and perform iterations of it
(3) Analyze the relationship between a linear program and its dual, including strong duality and complementary slackness
(4) Solve specialized linear programming problems like the transportation, assignment, sequencing, games theory, and queuing model problems
(5) The use of Operations Research approaches in solving real problems in industry; mathematical models for analysis of real problems in Operations Research.

Course Outcomes: After completion of the course, the learners will be able to:

(1) Capability to recognize the importance and value of Operations Research and mathematical modeling.
(2) Ability to formulate a managerial decision problem into a mathematical model;
(3) Recognize Operations Research models and apply them to real-life problems;
(4) Use various approaches to solve a mathematical model for various practical problems in industry.
(5) Describe dynamic programming terminology.

Syllabus

MODULE I

Introduction: Scope and limitations of O.R., Linear Programming: Mathematical formulation of the problem. Graphical solution and Simplex Method. **8L**

MODULE II

Linear Programming**:** Big-M Method, Concept of duality, Dual simplex method. **6L**

MODULE III

Transportation Model**:** Basic feasible solution by different methods, Finding optimal solutions, Degeneracy in transportation problems, Unbalanced transportation problems.

Assignment Model: Balanced and unbalanced assignments,Assignment to given schedules.**10L**

MODULE IV

Sequencing: Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines. **5L**

MOLULE V

Games Theory: Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point. **5L**

MOLULE VI

Queuing Model**:** Queuing systems and their characteristics, The M/M/1/FIFO/∞ Queuing system, Introduction to dynamic programming. **8L**

Text Books:

1. P. Rama Murthy , Operations Research, New Age, New Delhi
2. P.K. Gupta & D. S. Hira , Operations Research, S.Chand & Company Ltd, New Delhi.

References Books:

1. Hamdy A Taha, 1999. Introduction to Operations Research, PHI Limited, New Delhi.
2.Sharma, J.K., 1989. Mathematical Models in Operations Research, Tata McGraw Hill publishing Company Ltd., New Delhi.
3.Beer, Stafford, 1966. Decision and Control, John Wiley & Sons, Inc., New York.

RELIABILITY ENGINEERING

Course Code – ME608

Objectives : To understand the applications of reliability in engineering decision making

Contents:

Module-I
Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics. (6)

Module-II
Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve. (10)

Module-III
System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress-strength models, reliability block diagram. (10)

Module-IV
Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8)

Module-V
Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches; Maintainability Analysis: Repair time distribution, MTTF / MTBF, MTTR, availability, maintainability, preventive maintenance. (6)

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the concepts of reliability, availability and maintainability
2. Develop hazard-rate models to know the behavior of components
3. Build system reliability models for different configurations
4. Asses reliability of components and systems using field and test data
5. Implement strategies for improving reliability of repairable and non-repairable systems

Text Books:
(i) Ebeling CE, An Introduction to Reliability and Maintainability Engineering, TMH, New Delhi, 2004.

(ii) O'Connor P and Kleymer A, Practical Reliability Engineering, Wiley, 2012.

MACHINE TOOL DESIGN

Course Code – ME609

Objectives:

- Implement the tool design process when designing tooling for the manufacturing of a product.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufactured product.

Contents:

Module- I

Introduction to Machine Tools: Classification, similarities; various cutting tools and cutting fluids: speed of cutting, feed rate, machining rate and machining time. **(4 hrs)**

Module- II

Lathe: Construction, important mechanisms viz. apron, tail stock, head- stock, feed box; specification, operations e.g., taper turning, eccentric turning, screw cutting. **(4 hrs)**

Module- III

Milling machine: Construction, types specifications; cutters, dividing head, simple compound and differential indexing; various operations: Slab milling, angle cutting, slot milling, fly milling, slit gear milling, spur and bevel, T- slot milling, nature of operations, up and down milling. **(10 hrs)**

Module- IV

Shaper, Slotter, Planer: Construction, automatic feed mechanism, quick return mechanisms: operations e.g., horizontal, vertical and inclined machining, spline cutting, keyway cutting, contour machining. **(7 hrs)**

Module- V

Drilling machine: Construction, feed mechanism: Specification, geometry and nomenclature of twist drill, operations e.g. reaming, boring, tapping. **(5 hrs)**

Module- VI

Grinding Machines: M, N types and construction features, Operations e.g. Plane, cylindrical, internal and centreless grinding, tool and cutter grinding, grinding wheels- specifications, shapes, setting, dressing, truing. **(10 hrs)**

Course Outcomes:

At the end of the course, the student will be able to, Understand basic motions involved in a machine tool. Design machine tool structures. Design and analyze systems for specified speeds and feeds. Select subsystems for achieving high accuracy in machining. Understand control strategies for machine tool operations.

Text Books:

1. B.L.Juneja, G.S.Sekhon&Nitin Seth, Fundamentals of Metal Cutting & Machine Tools, New Age International Publications
2. P.N.Rao, Manufacturing Technology: Metal Cutting & Machine Tools, Tata McGraw Hill Publications.
3. G.K.Lal, Introduction to Machining Science ,New Age International Publications.
4. B.S.Raghuwanshi, Workshop Technology , Dhanpat Rai& Sons, Publications
5. HazraChandhari, Elements of Workshop Technology.